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Efficacy Diminution of the Rush Skeletonweed Gall Midge, *Cystiphora schmidti* (Diptera: Cecidomyiidae), by an Indigenous Parasitoid

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Rush skeletonweed, *Chondrilla juncea* L. (Asteraceae), a herbaceous perennial plant of Eurasian origin, was inadvertently introduced into eastern Washington during the late 1930s (Piper, 1985). The weed has since spread to infest over 810,000 ha of rangeland, semiarid pasture land, transportation rights-of-way, residential properties, and cropland in 12 counties. Heaviest infestations are confined to rangeland where *C. juncea* displaces livestock and wildlife forage plants but its encroachment into dryland wheat production areas has increased considerably during the last decade. The plant's extensive root system enables it to effectively compete with grain crops for moisture and nutrients. The fibrous, latex-exuding stems of mature plants can obstruct harvest machinery, making harvesting costly and difficult, if not impossible.

Herbicidal control of rush skeletonweed in non-cropland is often uneconomical because of low productivity of the land infested and the high cost of effective chemicals. Consequently, attention has been focused on the importation and release of exotic, host-specific biological control organisms. Natural enemies successfully utilized thus far include the rust fungus, *Puccinia chondrillina* Bubak and Sydow (Uredinales: Pucciniaceae), a gall mite, *Eriophyes chondrillae* (G. Canestrini) (Acari: Eriophyidae), and a gall midge, *Cystiphora schmidti* Rübsaamen (Diptera: Cecidomyiidae) (Lee, 1986).

The initial release of *C. schmidti* in 1976 was made with adults supplied by USDA-ARS Biological Control of Weeds Laboratory, Albany, CA, personnel (Piper, 1985). Detailed accounts of the biology and ecology of the gall midge in Europe and North America have been provided by Caresche and Wapshere (1975), Littlefield (1980), and Mendes (1981). The insect is active from April until late October and normally completes 4 to 5 generations during this time, the number being dependent upon environmental conditions. Females insert eggs beneath the epidermis of rosette and cauline leaves and stems. Reddish-purple, blister-like galls ca. 2.0–3.0 mm in length soon develop around the larvae feeding upon underlying leaf mesophyll or stem parenchyma. Pupation normally occurs within the galls. Pupae rupture the gall tissue with their cephalic horns to facilitate adult emergence. The life cycle, from egg to adult, may be completed in 24 to 44 days. Mature larvae, prepupae or pupae overwinter within stem or rosette leaf galls or as pupae in the soil in a state of temperature-induced quiescence.

The midge damages *C. juncea* in both the rosette and flowering stem stages. The production of anthocyanescent, hyperplasic gall tissue coupled with the feeding damage inflicted by the larvae decreases the quantity of photosynthate available for plant growth and maintenance (Caresche and Wapshere, 1975). Leaf and stem tissues are injured or destroyed, resulting in premature yellowing, desiccation, and death. Bolted plants can be so severely infested that almost no part remains ungalled. Such plants are stunted and produce up to 63% fewer flower buds than do unattacked plants of comparable size and age. Seeds that are produced exhibit decreased weight and viability (Mendes, 1981).

Mortality of both spring and fall produced rosettes, especially seedling rosettes, has been observed (Littlefield, 1980). *C. schmidti* is most damaging to fall rosettes, typically destroying in excess of 50% of the leaves produced and thus impair the weed's overwintering and competitive abilities. Variables affecting damage expression include rosette leaf size, plant vigor, and midge population density.

Exotic natural enemies introduced for biological weed control are frequently adversely impacted by indigenous predators, parasitoids, or pathogens (Goeden and Louda, 1976). In 1979, a parasitoid identified as *Mesopolobus* sp. (Hymenoptera: Pteromalidae), was first reared from midge galls collected at Nine Mile Falls, WA. Since then, the hymenopteran has been recovered from most sites where *Cystiphora* now occurs.

The life history and ethology of the wasp have been described by Wehling (1984). *Mesopolobus* sp. is a primary, solitary ectoparasitoid of *C. schmidti* third-stage larvae, prepupae, and pupae. The pteromalid completes 4 or sometimes 5 generations a year in eastern Washington. First generation adults emerge in mid-July, second generation adults appear during the first week of August, and each successive generation emerges ca. every 20 days thereafter until mid- to late October. Mature larvae, prepupae, and pupae overwinter inside stem galls.

The entomofaunas of 37 plant species found growing in association with rush skeletonweed throughout eastern Washington and suspected of harboring the indigenous/alternate host of the parasitoid were examined. No *Mesopolobus* sp. adults were recovered however.

The gall midge typically completes two generations before parasitoid activity becomes apparent in the field. Cecidomyiid galls produced on rosette leaves are not subject to attack by *Mesopolobus* sp. in nature even though the parasitoid will develop in such galls under greenhouse conditions. Studies conducted between 1981 and 1986 have shown that the parasitization rate of midge galls on stems is less than 10% in July, rises to between 45 and 65% by late August, approaches 85% during September, and may exceed 95% by mid-October prior to *C. juncea* stem senescence. This level of parasitism is similar to that recorded for *C. schmidti* in its area of indigenity where the parasitic eulophids, *Achrysocharella formosa* (Westwood) and *Tetrastichus* sp., together destroy in excess of 95% of the late season midge population (Caresche and Wapshere, 1975). In Australia, where the midge was also introduced for *C. juncea* suppression, parasitization by a native *Tetrastichus* sp. has reached 100% in some areas (J. Cullen, pers. comm.). It is most uncommon for an introduced weed phytophage to be parasitized by native Hymenoptera to the extent that *Cystiphora* is (Goeden and Louda, 1976).

A solitary, larval-pupal endoparasitoid also has been reared from midge-infested rush skeletonweed in California (L. Andres, pers. comm.) and Idaho (Littlefield, 1980) where it has attained densities like those experienced in Washington. It is not known if the wasp is *Mesopolobus* sp. or another species. In those areas of the western United States where biological control of *C. juncea* is being attempted, the high incidence of parasitism, intensified by attrition of midge immatures in stem galls resulting from summer and early fall grasshopper predation (Littlefield and Barr, 1981) and mortality of overwintering pupae in the soil attributable to excessive moisture influx during late winter and early spring, has appreciably reduced the midge force available to infest the small, highly vulnerable fall and/or spring rosettes. In spite of the occurrence of *Mesopolobus* sp., *C. schmidti* is still able to reach population levels injurious to the weed and is regarded as being an important biological control agent of rush skeletonweed.

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